

# Disruption of the Body Temperature Circadian Rhythm in Hospitalized Patients

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## ABSTRACT

### Background:

The circadian rhythm is believed to offer survival advantage with dysregulation being linked to immune response deficiencies and metabolic derangements. Diurnal temperature variation exists in humans, yet its preservation during illness is not well understood. Herein we present an analysis of diurnal body temperatures among hospitalized patients, with a focus on infectious versus non-infectious diagnoses.

### Methods:

Temperatures measured within 1/2 hour of 8am, 12pm, 4pm, 8pm, 12 am, and 4am from 16,245 hospitalized patients at a tertiary medical center were analyzed using descriptive statistics and t-tests.

### Results:

Although we found a diurnal pattern when analyzing the ensemble of temperatures from all patients, stratified by measurement site (oral, axillary, temporal, and tympanic), the through-to-peak difference was only 0.2F (0.1C), while previously reported diurnal difference in healthy volunteers was 1.9 °F (1.06 °C). Data from the core body temperature sites monotherm and rectal did not show any diurnal pattern. The peaks in body temperature occurred at 8 pm for all patients, regardless of age, which is similar to healthy people. However, the minimum body temperature was shifted to later times compared with healthy people (6am or 2 hours before rising in health) – for young patients (age 20-30 years, N=1285) the through was at 8am and for elderly patients (age 70-80 years, N=1736), it was at 12pm. Analysis of body temperature of individual patients showed that less than 20% of patients exhibited diurnal variation and among those showing variation, the trend was present only on the minority of hospitalization days. Interestingly, the presence or absence of an infectious process did not influence the proportion of patients showing diurnal variation.

### Conclusions:

Hospitalization is associated with disruption in the circadian rhythm as reflected by patients' body temperature, with shifting of the diurnal variation curve and blunting of the temperature range both in the ensemble and on the individual level. The trend is not influenced by having an infection. However, since core body temperatures tend to be the measurement site of choice in the ICU setting, we suspect that further obliteration of the diurnal rhythm occurs with more severe disease.

## RESULTS

### ENSEMBLE DIURNAL TEMPERATURE VARIATIONS OF HOSPITALIZED PATIENTS

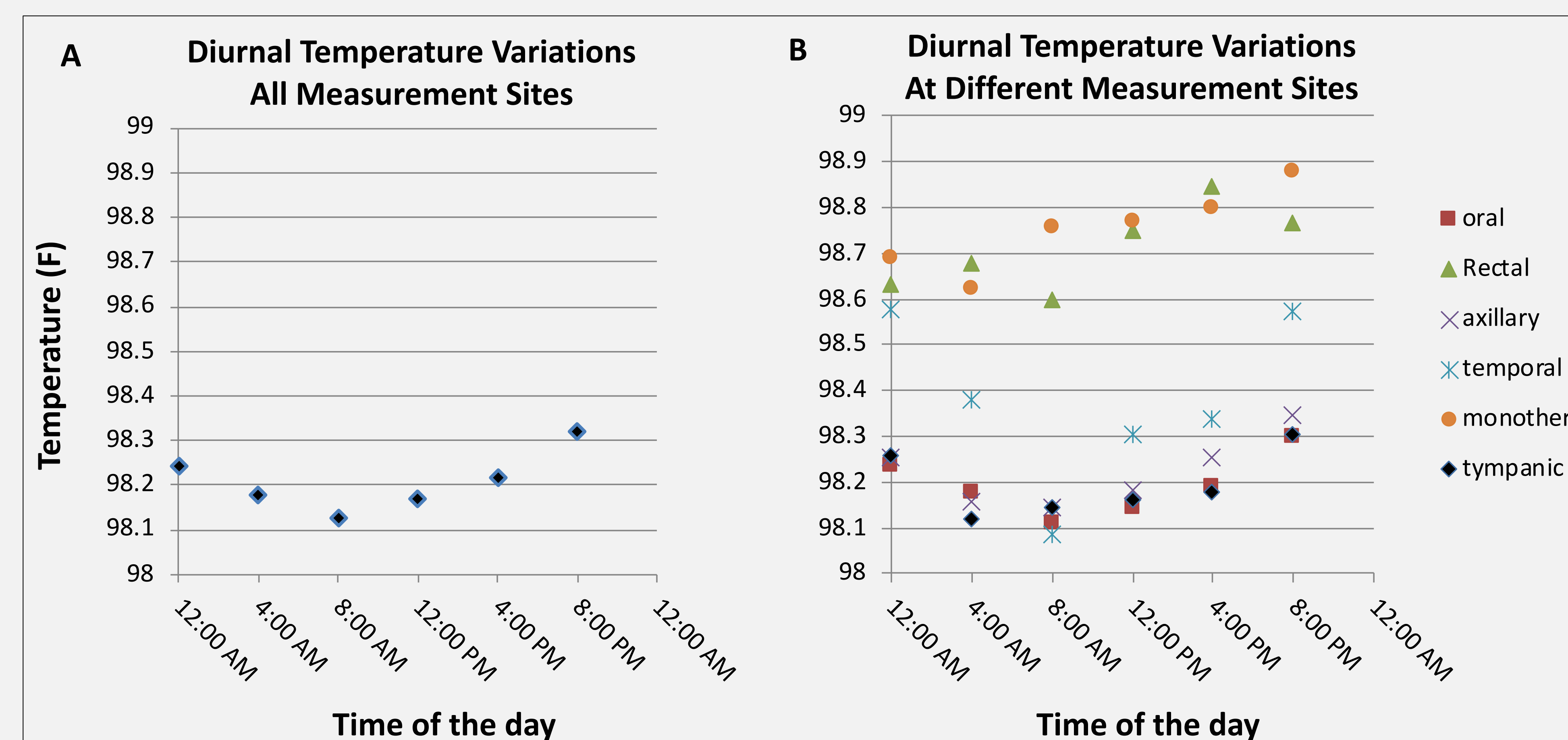


Fig. 1: Ensemble diurnal temperature variations of hospitalized patients. A) Diurnal trend using the data from all patients and all measurement sites; B) Diurnal trends when the data from all patients is grouped by measurement site.

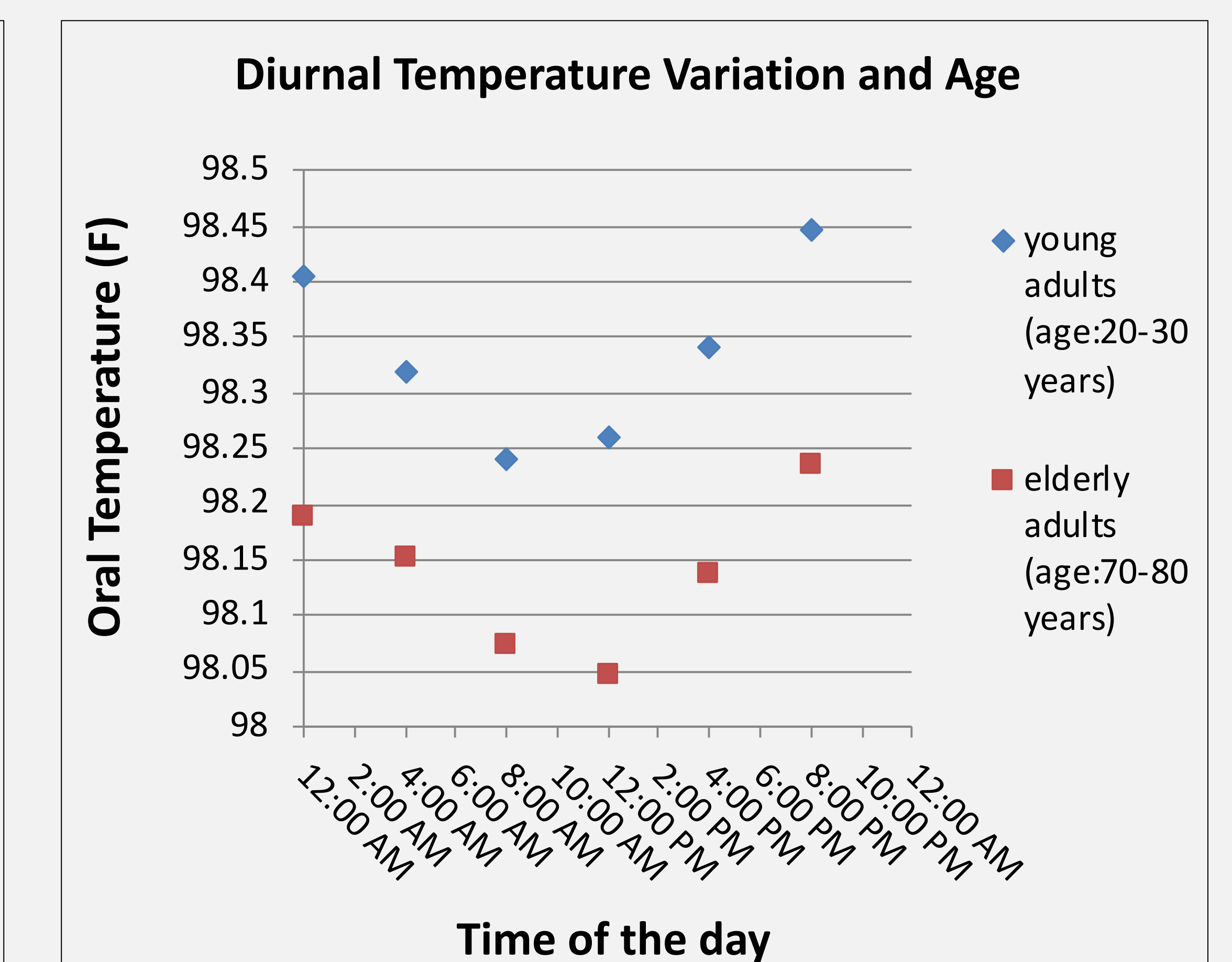


Fig. 2: Shift in the diurnal temperature curve with age.

### BODY TEMPERATURE OVER 24-HOUR PERIODS OF INDIVIDUAL HOSPITALIZED PATIENTS

#### PATIENTS WITHOUT INFECTION

#### PATIENTS WITH INFECTION

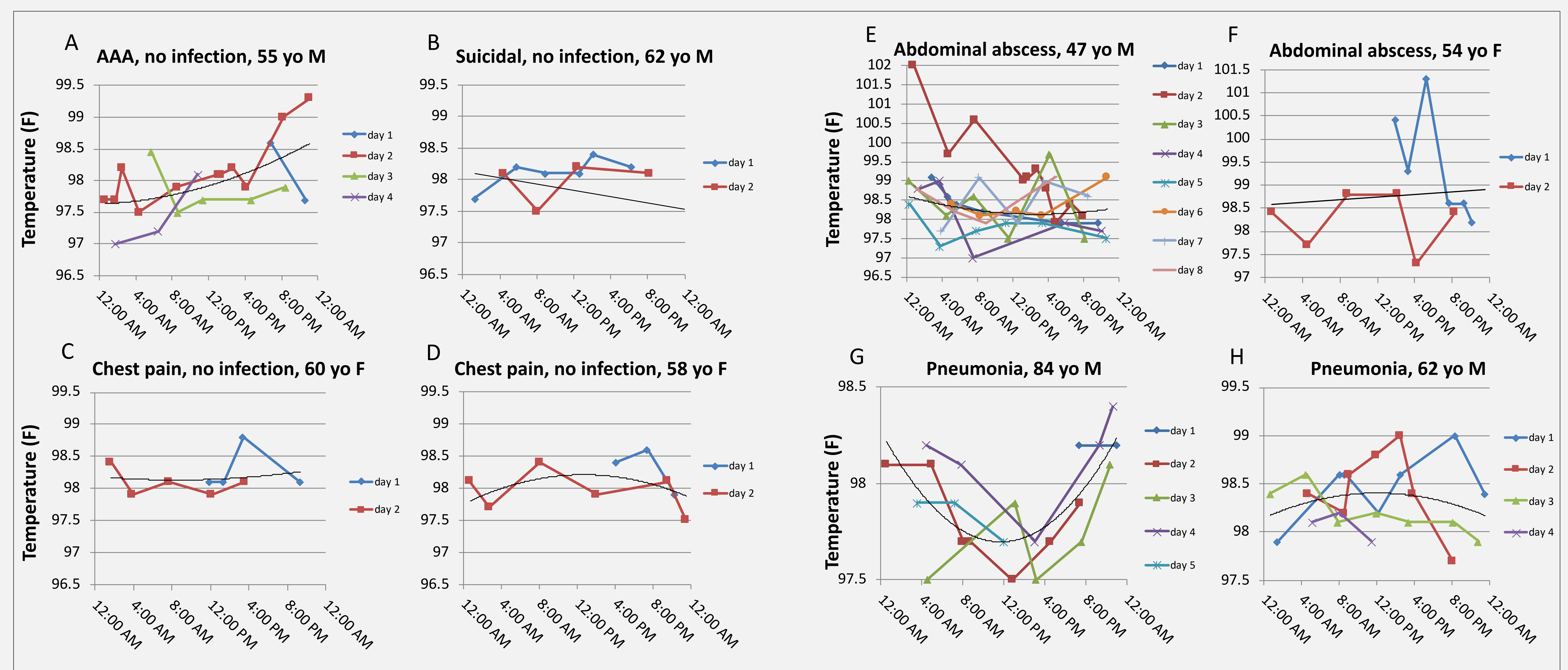


Fig. 3: Body temperature over 24-hour periods of individual hospitalized patients. A 2nd degree polynomial fit using all data points from all days is plotted in black. A) Patient with abdominal aortic aneurysm (AAA), without infection or fever; B) Patient with suicidal ideation, without infection or fever; C) Patient with chest pain, without infection or fever; D) Patient with chest pain, without infection or fever; E) Patient with abdominal abscess, with fever on day 2; F) Patient with abdominal abscess, with fever on day 1; G) Patient with pneumonia, without fever; H) Patient with pneumonia, without fever.

### SUMMARY OF THE DIURNAL BODY TEMPERATURE TRENDS OF INDIVIDUAL PATIENTS

		Diurnal trend present	no diurnal trend	% with diurnal trend
no infection	ACS rule out	1	6	14
	AAA	0	2	0
	suicidal ideation	1	1	50
<b>total no infection</b>		<b>2</b>	<b>9</b>	<b>18</b>
infection present	abdominal abscess	1	4	20
	pneumonia	0	3	0
<b>total infection present</b>		<b>1</b>	<b>7</b>	<b>13</b>

### CONCLUSIONS

- There is a disruption in the body temperature diurnal variation with blunting of the oscillation amplitude, shifting of the trough temperature, and in the majority of cases complete disappearance of this circadian trend
- The trend is not influenced by having an infection
- Core body temperature variation is affected more than peripheral, suggesting association with illness severity